AT the University of Illinois assistant professors have been appointed as follows: Dr. John Byrnie Shaw, mathematics; Dr. George F. Arps, of Indiana University, psychology; Mr. David Varon, of New York City, architectural design, and William Thomas Bawden, of the State Normal School, Normal, Ill., engineering.

RECENT appointments in the School of Mines of the University of Pittsburgh are as follows: Horatio C. Ray, B.S., instructor in metallurgy; Harry N. Eaton, A.M., instructor in geology and petrography; Henry Leighton, A.B., instructor in mining geology and mineralogy; Harry B. Meller, E.M., instructor in mining.

THE Toronto correspondent of the New York *Evening Post* states that appointments at the university have been made as follows: Dr. J. A. Arnyot, director of the laboratory of the provincial board of health, to be professor of hygiene, in succession to Dr. William O. Wright, resigned; H. E. T. Haultain, professor of the new chair of mining engineering; Dr. W. H. Piersol, associate professor of histology and embryology; Dr. K. C. McIlwraith, associate professor of obstetrics; S. R. Creaser, lecturer in surveying; W. W. Frey and J. J. Traill, lecturers in mechanical engineering; J. H. White, lecturer in forestry and botany; Alex. McLean, lecturer in geology.

DR. HOWARD L. BRONSON, assistant professor of physics in McGill University, has been appointed to the chair of physics in Dalhousie University, Halifax, vacated by the resignation of Professor A. S. McKenzie to accept a chair in the Stevens Institute of Technology.

## *DISCUSSION AND CORRESPONDENCE*

### THE BEARING OF PSYCHROMETER READINGS ON MEASUREMENTS OF MARTIAN AQUEOUS VAPOR

TO THE EDITOR OF SCIENCE: Referring to Dr. Abbot's letter to Director Percival Lowell,[1] the point at issue can not be settled by psychrometer readings, taken merely at the earth's surface.

Dr. Slipher, in commenting upon the Flagstaff Mars-moon spectrogram Rm 3050, taken at the Lowell Observatory, January 15, 1908, when the psychrometer indicated 1.30 grains of water-vapor per cubic foot of air, and comparing it with plate Rm 3062, taken on January 21, with a vapor-reading of 1.02 grains, says:

> A long series of exposures to the spectrum of the moon at different altitudes, made on the same night [January 15] . . . verify the lunar images of the Mars spectrogram in showing that the moisture in our air was relatively very much less than for plate Rm 3062, notwithstanding the meteorological records to the contrary. The strength of the *a* band depends upon the actual amount of aqueous vapor in the light path and is, therefore, a very reliable measure, whereas the meteorological observations can not be reliable for they depend upon the moisture in a small sample of air at the earth's surface which may be very different from what it is a short distance above.[2]

Director Campbell says:

> It would be interesting to know how much vapor was traversed by the rays of Mars and the moon when the spectra were recording themselves on the sensitive plates, but to speculate on the subject, from the thermometer readings, seems useless, in view of the unknown law of distribution of vapor in the strata above the thermometers. The vapor bands in the spectrograms themselves furnish the only known rational method of estimating the quantity of vapor traversed.[3]

The same principle is recognized in my "Reply to Campbell's criticism," where I say:

> It is the distribution of moisture through the entire air column that we should like to know, and this is hardly affected by such surface changes as occur in an arid region. . . . Any great accuracy in the determination of surface humidity would be labor wasted for the present purpose. A mean diurnal, or possibly a mean monthly, humidity may be quite accurate enough.[4]

[1] SCIENCE, June 24, 1910, p. 987.

[2] V. M. Slipher, "The Spectrum of Mars," *Astrophysical Journal*, Vol. 27, No. 5, p. 401, December, 1908.

[3] W. W. Campbell, "The Spectrum of Mars as Observed by the Crocker Expedition to Mt. Whitney," *Lick Observatory Bulletin*, No. 169, p. 153, October 1, 1909.

[4] Frank W. Very, "Water Vapor on Mars—Reply to Campbell's Criticism," *Lowell Observatory Bulletin*, No. 43, p. 240.

Thus the three investigators of the *a* group in the Martian spectrum, Slipher, Campbell and Very, are in complete agreement as to the failure of the psychrometer readings to give reliable information about the humidity of the total air column, which is the important datum of this test. If any further demonstration of this point is needed, it may be found in Campbell's spectrogram No. 3, September 2, 1909, where the mean light paths were 5.15 for Mars, 3.61 for the moon, and the moisture by sling psychrometer was about 2.9 grams per cubic meter at the time of the Mars spectrogram, but only about 0.3 grams ±, when the lunar images were being recorded. Yet notwithstanding the presence of a quantity of terrestrial aqueous vapor about fourteen times as great for the Mars spectrogram as at the time of the lunar impression, if we are to trust the meteorological records as Dr. Abbot wishes, Professor Campbell merely notes that little *a* "seems to be a shade stronger in *Mars* than in the moon." Evidently, either the psychrometer readings are not to be relied on, or the photographic process must have been very insensitive. Perhaps a doubt may be permitted on both of these scores.

Dr. Abbot holds that, while the weather may have been bad during a large part of his stay on Mt. Whitney, the conditions as to humidity were favorable on the nights when Director Campbell made his observations, and that the spectrograms are "entirely conclusive," while there is "no evidence at all of water-vapor on Mars." *Per contra,* the fact is that in spite of the low relative humidity on the summit of the mountain on the nights of September 1 and 2, we have no knowledge of the conditions in the air column through which the rays passed, except as these may be surmised from the general seasonal and regional meteorological data. The top of a high mountain is the seat, during the day time, of an abnormal local ascensional movement of air, heated by contact with the insolated slopes of the mountain. At night the convection is reversed. Air from an elevation above the summit descends, and with relative humidity reduced by virtue of compression in the downward movement, a nocturnal abnormal condition of local dryness is liable to be produced. In the free air, far from the mountain top, quite other conditions may prevail.

The upper air is affected by the great general and seasonal movements of the atmosphere. In summer, a mantle of aqueous vapor distributed through a wide range of altitude prevents excessive radiation to the celestial spaces. The night temperature at the summit of the mountain in September descended to a little below the freezing point, but this does not indicate the complete removal of summer conditions in the upper air over the whole surrounding country. The depression of humidity may have been, and probably was, largely local, and in any case, considering the altitude (14,500 feet), the cold was not exceptionally severe, and does not point to any extensive withdrawal of a protective envelope of vapor from the surrounding region, such as occurs in winter. On the contrary, since the weather over the whole southwest had been for some time excessively rainy, the entire air column over the region, taken as a whole, was probably unusually replete with moisture. The great mass of air through which an inclined and long line of sight passed, as in Campbell's spectrogram No. 3, where the altitudes were 11°.2 and 16°.1, was comparatively unaffected by the local air movements of the mountain top. The spectrograms prove nothing definitely. Interpreting them as Dr. Abbot would have us do by the psychrometer readings, they are barely able to detect a variation of moisture in the ratio of fourteen to one in the case noted above. By Campbell's own account they are poor specimens, being weak in the neighborhood of *a,* and having other photographic defects. It is in the photographic process that the real crux of the problem lies. I can best illustrate this by an example.

Being engaged in a revision of Rowland's intensities of the solar Fraunhofer lines, I have had occasion to note the exceptional uncertainty of those estimates which lie on the

verge of the barely visible. For instance, examining a particular line to which Rowland assigns the intensity and character denoted in his notation by the symbols 0000 N d ? (meaning one of the faintest lines, hazy and suspected of duplicity) on the excellent photograph by Higgs, I find this line to be invisible throughout a large part of its extent; but at a particular spot on the spectrogram the line comes out clearly double, then disappears, and is only seen again as a faint nebulous spot at another point in the line. Here the variations of sensitiveness at different points on the same photographic plate are responsible for changes from the clear definition of a close double, to invisibility. How absurd would be the proposition that this particular line must be dropped from the list of acquired data of solar spectroscopy, because it may fail to appear on a given plate! A fact of science which is difficult to determine, being once acquired, is not overturned because of failure to reproduce it. If the previous determination is satisfactory, the only assignable weight which can be given to the failure is zero.

It is quite possible that the renewed failure of Campbell and Albrecht to secure positive evidence of either water-vapor or oxygen in the Martian spectrum[5] is to be attributed to photographic difficulties; but the influence of the high dilution, that is to say, of the greater altitude and lower pressure of the Martian atmosphere, should not be overlooked.

We know from the behavior of different emission lines in the spectrum of the same element under varying conditions of temperature, pressure or mode of electrical excitation, that individual lines, even when very strong, may disappear at the same time that weaker lines are reenforced. These and other variations are to be expected in the lines of absorption also. Before the significance of the absence of particular spectral lines can be determined, a critical study of the causes of their variation needs to be made; and if, in addition, the lines are very weak and barely capable of being photographed, the uncertainties of the photographic process must also be considered.

[5] SCIENCE, June 24, 1910, p. 990.

In *Lick Observatory Bulletin*, No. 169, Professor Campbell subscribes to the opinion, held by Vogel and Keeler, "that high resolving power was not necessary, or even desirable, in visual observations of spectra no brighter than those of Mars and the moon." This of course does not necessarily apply to photographic spectra; but we may inquire whether, owing to a broadening and weakening of individual absorption lines when a given mass of absorbent is distributed through a large volume of diluent, the effect of a group of broad and faint lines, combined into one indistinguishable band in an instrument of low power, may not be more easily recognized than individual lines photographed with high dispersion; and whether possibly the peculiar conditions of the Martian atmosphere may not favor such a constitution of the Martian, as distinguished from the terrestrial bands?

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June 28, 1910

*Addendum:* The method of distinguishing Martian and telluric absorption lines by the velocity-shift of the Martian lines at quadrature is not new. It was not only explained and advocated by Dr. Percival Lowell, but was actually tested at the Lowell Observatory by Dr. Slipher in 1905, with the same negative result that Professor Campbell and Dr. Albrecht now obtain in repeating the experiment. A full account of the method and its results was published at the time in *Lowell Observatory Bulletin*, No. 17. That the method is not a delicate one is shown by its failure hitherto, when applied to Venus which possesses an undoubted atmosphere.

F. W. V.

## *QUOTATIONS*

### MEDICAL APPOINTMENTS AT VIENNA

THE half-hearted way in which the requests of Professor Strümpell for a modern outfit for his clinic were met by the authorities has had an unexpected result. The professor has "given notice" he will leave his post at once